RHIC Correction System, Reduction in Power Supplies

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Introduction

This note summarizes the suggested temporary reduction in the power supplies for the RHIC Correction System in order to bring down the cost of the power supplies. These proposed reductions are first briefly summarized; then some detailed considerations are given of the effects of these changes.

The power supplies for the random quadrupole a_1/b_1 correction system are omitted. The only remaining random b_1 correction is that provided by the insertion quadrupoles. The only remaining random a_1 correction is the 2 power supplies for the coupling correction system. Note the coupling correction system, having 2 families of a_1 quads in the insertions, is considered as being separate and distinct from the random quadrupole a_1/b_1 correction system which has 36 families, mostly in the arcs.

The power supplies for the insertion quads are considerably reduced due to the following assumptions.

1) The machine operates with $\beta^* = 6$ at all energies.

2) The ν-values can be varied by $\pm.25$.

The excitation of all the insertion quads can be individually varied. The power supplies are large enough to provide for a ν-variation of $\pm.25$, plus about 2% current variation to control β_x, β_y and X_p at the crossing points, plus the amount required by the differences in excitation of inner and outer quads of the same type (e.g. Q1I and Q1O)

The closed orbit correction system power supplies are reduced in number by a factor 2 in the arcs only. The quad bypass current strength is reduced from 1500A to 500A. The BS1I and BS1O will have different lengths and will not have separate power supplies.

Philosophy

The potential of the correction system will not be reduced - all leads and coils will be provided; only power supplies will be omitted.

Dangers

Predictable effects are not a problem - unpredictable effects (e.g. beam-beam interaction) are, when things go wrong, it won't be easy to restore power supplies.

a_1/b_1 System

Effects of Random a_1/b_1

1) Random $\Delta\beta_x/\beta_x$, $\Delta\beta_y/\beta_y$, X_p, Y_p.
2) Loss in aperture $\sim\pm 4$ mm (depends on choice of ν_y, ν_y - may be larger). Reduced aperture reduces beam lifetime, not luminosity so much.
3) Loss in luminosity - larger beam size at crossing point.
4) Increased beam-beam interaction - random $\Delta\nu_{\text{beam-beam}} \simeq 30\%$, may be more.

b_1 Correctors

N_o b_1 in arcs.

b_1 correction in insertion $\simeq 2\%$ to control $\Delta\beta/\beta$ and Xp at crossing point. (Based on CBA study.)

Tracking study needed to see effect of random b_1 on aperture.

Synch study needed to find b_1 - correction needed to correct $\Delta\beta/\beta$ and X_p at crossing point.

a_1 correction

a_1 generates coupling and Y_p (vertical dispersion).

Full coupling correction provided

2 power supplies for a_1 in insertions. a_1 near Q2 → Q3

Y_p Correction at crossing point

No a_1 coils used.

Use vertical displacement of the closed orbit to correct Y_p.

($\Delta Y_{co} \sim \pm 5$ mm.)

Do we have enough y-space?

For $\gamma \simeq 30$, no dispersion gives 7.5 mm space; also $t \leq 10$ hrs. has more vertical space.

For $\gamma > 30$ more space as beam shrinks.

This is a complicated question - but some correction of Y_p seems possible

a_o/b_o closed orbit

Use CBA experience - reduce power supplies in arcs by 1/2 in number, removes 144 power supplies. This needs a computer simulation study to determine the quality of the closed orbit correction with the reduced number of power supplies.

Insertion quads

All have (effectively) individual trims to give $\Delta\nu = \pm .25$, plus 2% current variation for controlling $\Delta\beta/\beta$ and ΔX_p at crossing point, plus the current required to provide the small unequal excitation of the insertion quadrupoles in the inner and outer arcs.

The 2% for controlling $\Delta\beta/\beta$ and X_p at the crossing points was derived from the CBA experience where 4% was found to be required - and 2% is 1/2 of the required amount. This 2% number needs to be checked for RHIC by doing a SYNCH study.

Quad Bypass

Reduce current 1500A → 500A, which allows $\Delta\nu > \pm 1$.

BS1

BS1 will have different lengths for BS1I and BS1O - they will have the same excitation as the normal dipoles and produce the required $\int B\, d\ell$ within an error of a few parts in 10^4.

BC2

Increase current, I = 2000A → 2400A

The above work represents the results of the combined efforts of the Correction System Committee which includes J. Claus, G. Cottingham, G. Dell, H. Hahn, J. Herrera, S.Y. Lee, G. Parzen, R. Shutt and P. Thompson.